

# Additively Manufactured Monolithic LOx/Methane Vortex RCS Thruster, Phase I

Completed Technology Project (2015 - 2015)



## Project Introduction

Parabilis Space Technologies (Parabilis), in collaboration with Orbital Technologies Corporation (ORBITEC), proposes to use additive manufacturing technology to fabricate a complete liquid oxygen (lox) and liquid methane Reaction Control System (RCS) thruster in response to solicitation H2.01, In-Space Chemical Propulsion. The thruster will be fabricated as a monolithic part that includes the injectors, combustion chamber, and nozzle. This thruster design will leverage a propulsion architecture especially amenable to additive manufacturing: ORBITEC's revolutionary Vortex Combustion Cold-Wall (VCCW) technology. Through additive manufacturing, Parabilis will reduce the cost, increase reliability, decrease complexity, and significantly reduce CAD-to-part design cycle time. Lox-methane is an attractive propellant combination for future NASA missions, however significant technical challenges remain. This proposed innovation provides novel solutions to challenges for lox-methane rocket engines as requested by the H2.01 solicitation. Specifically, this proposal includes innovations for RCS class thrusters, including advances in additive manufacturing, propellant injectors, and combustion chamber design. Additionally, the use of VCCW technology will likely mitigate adverse effects of multiphase or intermittent gas phase operation. Due to the low wall temperatures inherent to VCCW technology, the proposed thruster will provide almost no additional thermal loading to the main vehicle structure. The proposed thruster should obtain a vacuum specific impulse significantly in excess of 325 s for vacuum operation. Phase I development objectives include preliminary design of the thruster and cold flow testing of a thruster prototype that will be used to test the applicability of several additive manufacturing techniques. By the end of Phase I testing the technology will be at a TRL 4 level.

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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Parabilis Space Technologies, Inc.	Lead Organization	Industry Historically Underutilized Business Zones (HUBZones)	SAN MARCOS, California
Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas

Primary U.S. Work Locations	
California	Texas

## Project Transitions

**June 2015:** Project Start

## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Organization:

Parabilis Space Technologies, Inc.

### Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

### Program Director:

Jason L Kessler

### Program Manager:

Carlos Torrez

### Principal Investigator:

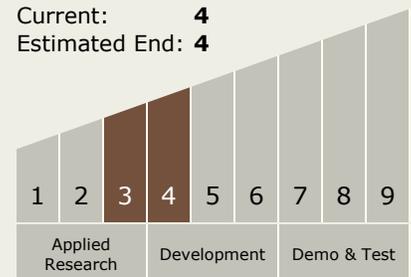
Christopher S Grainger

## Technology Maturity (TRL)

Start: **3**

Current: **4**

Estimated End: **4**



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✓ **December 2015:** Closed out

**Closeout Summary:** Additively Manufactured Monolithic LOx/Methane Vortex RCS Thruster, Phase I Project Image

**Closeout Documentation:**

- Final Summary Chart Image(<https://techport.nasa.gov/file/138659>)

## Images



### Briefing Chart Image

Additively Manufactured Monolithic LOx/Methane Vortex RCS Thruster, Phase I

(<https://techport.nasa.gov/image/132623>)

## Technology Areas

### Primary:

- TX01 Propulsion Systems
  - └ TX01.2 Electric Space Propulsion
    - └ TX01.2.1 Integrated Systems and Ancillary Technologies

## Target Destinations

Earth, The Moon, Others Inside the Solar System, Outside the Solar System, The Sun, Mars